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NON-PARAMETRIC ESTIMATE OF SPIDER SPECIES RICHNESS IN BARPETA DISTRICT, ASSAM, INDIA

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ABSTRACT

Species richness is the number of species in a sample unit and a component of species diversity which incorporates evenness or relative abundance of species. The objective of the study is to measure the spider diversity in Barpeta district of state Assam, India, which helps in conservation, biodiversity management and environmental policy making and creates baseline information for the future research. After two years of collections (June2008-May2010), 69 species belonging to 44 genera and16 families were collected. Visual search sampling method (Robinson, et al. 1974; Sebastian, et al. 2005) was adopted to sample the spider fauna from quadrates selected at random of selected study sites. The collection method adopted was as described by Coddington, *et al.* (1991) and Toti, *et al.* (*2*000). Specimens were preserved in 70% ethyl alcohol and identified in Zoological Survey of India, Kolkata. Non parametric estimate of spider species richness is generated using the two estimation Chao (Chao, 1984) and Jack-Knife (Heltshe and Forrester, 1983). Out of 69 species, 6 are singletons, 7 are doubletons and 9 are unique to the each sample unit. The non parametric estimators Chao and Jack-knife generates a species richness of spider estimate 72-78 actual spider species in the Barpeta District. Chao estimator estimates 71.57 ±2.39 spider species and Jack knife estimator estimates 77.93±4.38, which shows that Chao estimator is more reliable. This study is of particular value as estimate of spider species richness has not been generated before in N.E. region where works on spiders are not comprehensively carried out.

Key words - Chao, Jack-knife, visual search method.

INTRODUCTION

Spiders belongs to class Arachnida, order Araneae of Phylum Arthropoda. The basic characteristics shared by them are- body divided into cephalothorax and abdomen, presence of eight legs (made up of seven segments each) and pedipalps, capacity to produce silk and possess no antenna. They are identified for their webs and web silk with future prospects. All spiders can make silk but many don't spin web, they may use the silk to wrap the

prey, to hang from and to make egg sacs and nests. They are ubiquitous in terrestrial ecosystems and abundant in both natural and agricultural habitats (Nyfeller & Benz, 1987; Turnbull, 1973). They play a significant role in the regulation of insect and other invertebrate populations in most ecosystems (Raghavendra, 2001; Wise, 1993).Spider surveys may provide an effective means for measuring the impact of habitat degradation or land use change on biodiversity. Baseline studies involving spiders as biological indicators have been conducted elsewhere; e.g. Allred, 1969 and Allred & Gertsch, 1976 documented spider diversity in Arizona and Utah after new power plant installations and in Nevada at the Nevada Nuclear Test Site. In spite of several applied values, spiders have received cursory attention. In conservation efforts, ecological significant groups like spiders are often neglected. Ironically, the spider diversity in Assam is still not fully explored. Manoranjan Barman (Barman, 1975; 1979) has done a work on spider of Khasi and Jantia hills of Meghalaya, N.E. region in seventies of last century. Tikader and Biswas (1970; 2000A; 2000B; 2003; 2004; 2006; 2007) also collected some information on diversity of spiders of Northeastern states like Tripura, Meghalaya, Sikkim, Manipur, Arunachal Pradesh and Mizoram except Assam. Northeastern region of India is one of the richest hotspots of the world, has remained poorly explored, and much of its diversity is being lost without any record. As spiders species of Assam are poorly documented & no research has been done so far for the applied use of spider & its related product in this region. The study was carried out with the objectives to document the spider species diversity and richness of Barpeta District of Assam.

Species richness is the most popular, simplest and quicker concept of generating diversity of a species bio-community. More specifically species richness represents the number of species of a particular bio-community available in the population (area under consideration). The non-parametric estimate of spider species richness in Barpeta district is the basic priority of the study. For the estimation of species richness from samples, various extrapolation methods are available. In this study we shall estimate the spider species richness in Barpeta district with the popular estimators Chao and Jackknife. As Singh(2012) have done the abundance distribution of spider species of the Barpeta District of Assam ,so in this paper we have estimated the spider species richness with the non parametric estimators- Chao and Jackknife. After two years of collections (June2008-May2010), 69 species were collected belonging to 16 families and 44 genera. Out of 69 species, 6 are singletons, 7 are doubletons and 9 are unique to the each sample unit. The non parametric estimators Chao and Jack-knife generates a species richness of spider estimate 72-78 actual spider species in the Barpeta District. Chao estimator estimates 71.57 ±2.39 spider species and Jack knife estimator estimates 77.93±4.38, which shows that Chao estimator is more reliable. This study is of particular value as estimate of spider species richness has not been generated before in N.E. region of India where works on spiders are not comprehensively carried out.

MATERIALS AND METHODS

Study area- Our study area belongs to Barpeta district of state Assam, North East region, India. The total area of the district is 3245 sq.km. The area is located between 26°5' N to 26°49' N latitude and 90°39'E to 91°17'E longitude. Elevation of the district ranges from 61 to 110 mean sea level. Temperature ranges between 6° - 36°C.Humidity of the area ranges between 60 % – 85% during a year.

Study Time-The study was carried out during the year June 2008 to May 2010. The year was divided into four seasons - June to September, October to November, December to February and March to May. Most collection were made between the hours of 9 A.M. to 6 P.M. Sampling occurred under suitable weather conditions for spider collection, temperatures between 15–38 °C.

Sampling-Visual search sampling methods (Robinson, et al. (1974); Sebastian, et al. 2005) was adopted in this study to sample the spider fauna from quadrates selected at random of selected study sites. Random sampling was done from the same selected study sites in all the seasons. A total of 36 hours was spent in each site across the four seasons. All 10 political blocks of the district were taken and from each block, 3 plots were selected. Each plot is again divided into 4 different types of habitat i.e. Grassland cum bushy, Marshy, Residential and agricultural area. Therefore, a total of 120 sample sites. Sampling was done from the same selected study sites in all the four seasons. A total of 9 hours were spent in each site for each season, totaling 36 hours of sampling time across the four seasons. Collection was done from four quadrates (1m x 1m) placed in the respective corners of 10m x 10m area and the area was searched for webs and all the vegetations were thoroughly examined from bottom to top. (Adapted from Environmental Science Laboratory Manual, 1995).

Trapping techniques-The following techniques were carried out according to Coddington, *et al.* (1991); Toti, *et al.* (2000) -

1) Aerial hand collection i.e. collecting spiders found above knee level for that a sweep net was used to capture spiders seen high in the vegetation.

2) Ground hand collection i.e. collecting spiders found below knee level in the vegetation or leaf litter.

3) The beat-sheet method of collection performed by stretching out a light-colored cloth under the tree branch or other low vegetation and grabbing the branch and shaking it vigorously. Spiders resting or nesting in this vegetation fall onto the cloth.

Preservation technique -The spiders collected from each site was preserved together in 70% ethyl alcohol with proper labeling of locality, date of collection and other notes of importance.

Identification- The spiders were identified to the species level except the immature ones, which could be identified only to the generic level. Specimens were identified in Zoological Survey of India, Kolkata and with the help of available literature like 'Handbook of spiders' by Tikadar (1987) and 'Spiders of India' by Sebastian and Peter (2009).

Non-parametric estimates of spider species richness-The most important and simplest non parametric estimators namely Chao and Jack-knife of richness estimate in Biostatistics analysis has been employed to characterize an estimate of spiders locally available in the Barpeta district of Assam. The theoretical basis of these estimators described by Southwood and Henderson (2000) has been discussed in the following sections respectively.

***Chao estimate*:** Using the observed number of species in the sample with singletons and doubletons species, Chao estimator is –

$$S^*_{chao} = S_o + \frac{a^2}{2b}$$

Where, S* is the estimated number of species.

S_o is the observed (actual) number of species in the sample.

a is the singletons species in the sample.

b is the doubletons species in the sample.

And the dispersion of the above Chao estimator is –

$$Var(S^*_{chao}) = b[\left(\frac{R}{4}\right)^4 + R^3 + \left(\frac{R}{2}\right)^2]$$

Where, R is the ratio of number of singletons to doubletons species.

***Jack-Knife*:** Heltshe and Forrester (1983) developed he Jack-knife estimator as –

$$S^*_{jack} = S_0 + L(\frac{n-1}{n})$$

Where, S* is the estimated number of species.

S_o is the observed (actual) number of species in the sample.

L is the number of species which appears in only one sample unit.

n is the number of sample units.

The dispersion of the Jack-knife estimator is –

$$Var(S^*_{jackk}) = \frac{n-1}{n}(\sum_{0}^{S_o} j^2 f_j - \frac{L^2}{n})$$

Where, f_j is the number of sample units having exactly j of the L species only found in one sample.

RESULTS

In 120 sample units, 2232 spiders were collected, of which 1162 individuals were adult which belong to 16 families, at least 44 genera and 69 species. Out of 69 species, 6 are singletons, 7 are doubletons and 9 are unique to the each sample unit. Intensity of the sample, i.e. the ratio of adult to species was 16.8: 1. The juvenile spiders in the sample were 47.9 %. The percentage of singletons among adults was 0.51 %.

Table 1, shows the list of observed species (with adult individuals) and the number of individuals according to collecting techniques.

For chao, S_0 = Observed number of species in the sample (69)

a = Number of species that are represented by only a single individual in thesample (Singletons= 06)

b = Number of species that are represented by exactly two individuals in the sample (Doubletons=07)

For Jack-knife, L = Number of species which appear only 1 sample unit (09)

n = Number of sample unit (120)

The Chao and Jack-knife estimates of the actual spider species richness of the district with their respective standard errors shown in the table 2. In table 3, numbers of all collected individuals and species are compared according to the collecting techniques and the time of sampling.

DISCUSSION

The non parametric estimators Chao and Jack-knife generates a species richness of spider estimate 72-78 actual spider species in the Barpeta District. Individually, Chao estimator estimates the 72 actual spider species with 2.39 standard error i.e. Chao estimator estimates 71.57 ±2.39 spider species. From the result shown in table 1, we can conclude that Chao estimator is more reliable than the Jack-knife estimator in spider species richness with only 2.39 S.E than that of Jack-knife 4.38, which also established the studies of Henderson (1989) and Magurran (1988) on present – absent data that the Chao estimator applied to such data to be most reliable and cost effective. This study also reveals the fact that out of 69 species, 6 are singletons, 7 are doubletons and 9 are unique to the each sample unit. Intensity of the sample, i.e. the ratio of adult to species was 16.8: 1. The juvenile spiders in the sample were 47.9 %. The percentage of singletons among adults was 0.51 %. The total number of species collected was more by aerial methods of collection i.e. 39 which constitutes the 56.52 % of total species, followed by ground method and beating method of collection. We can conclude that the low number of individuals recorded for all the species might be for the relatively small populations and are

Table 1. Species and numbers of adult spiders in the Barpeta District, Assam.

Collecting methods, numbers and sex of individuals (m=male, f=female), and the status of 'rare' species (a= singletons, b= doubletons, L= species unique to one sample unit).

Sr.No.	Family	Taxon	Collection methods			Total (Status)
			Arial	Ground	Beating	
1.	Araneidae	*Araneus mitificus*	1m/14f	2m/3f		20
2.		*Araneus inustus*	7m/25f	4m/1f		37
3.		*Argiope aemula*	1m/20f	2m/2f		25
4.		*Argiope anasuja*	2m/14f			16
5.		*Argiope catenulate*	4f			4
6.		*Argiope pulchella*	25m/114f			139
7.		*Cyclosa bifida*	2f			2(b,L)
8.		*Cyclosa confraga*	1m/3f			4
9.		*Cyclosa hexatuberculata*	7f			7
10.		*Cyclosa spirifera*	1m/5f			6
11.		*Cyrtophora cicatrosa*	4f		2f	6
12.		*Cyrtophora moluccensis*	5f		1m/1f	7
13.		*Gasteracantha kuhli*	1m/1f		5f	7
14.		*Neoscona mukerjei*	2m/35f		7f	44
15.		*Parawixia dahaanii*	1f		2f	3

Sr.No.	Family	Taxon	Collection methods			Total (Status)
			Arial	Ground	Beating	
16.	Hersiliidae	*Hersilia savignyi*	1m/1f			2(b)
17.	Linyphiidae	*Lepthyphantes sp.*			4m/8f	12
18.		*Lynyphia striata*			11f	11
19.	Lycosidae	*Lycosa mackenziei*		1m/32f		33
20.		*Lycosa tista*		2m/12f	5f	19
21.		*Pardosa birmanica*		5m/32f		37
22.		*Pardosa pseudoannulata*		4m/13f		17
23.		*Pardosa sumatrana*		7m/30f		27
24.	Nephilidae	*Herrennia multipuncta*	1m/2f			3
25.		*Nephila kuhlii*	1m/3f			4
26.		*Nephila pilipes*	4f			4
27.	Oxyopidae	*Oxyopes birmanicus*		2m/44f		46
28.		*Oxyopes javanas*		8m/17f		25
29.		*Oxyopes lineatus*		5m/16f		21
30.		*Oxyopes shweta*		4m/25f		29
31.		*Oxyopes sunandae*		10m/16f		26
32.	Philodromidae	*Tibellus elongates*		1m/1f	2f	4

Sr.No.	Family	Taxon	Collection methods			Total (Status)
			Arial	Ground	Beating	
33.	Pholcidae	*Artema Atlanta*	4m/23f			27
34.		*Crossopriza lyoni*	3m/68f			71
35.		*Pholcus phalangioides*	1m/14f			15
36.		*Smeringopus pallidus*		4f		4
37.		*Uthina atrigularis*	1f		1f	2(b)
38.	Pisauridae	*Perenethis venusta*	20f		3f	23
39.		*Polyboea vulpine*	2f		2f	4
40.		*Thalassius albocinctus*		1m/8f	2m/11f	22
41.	Salticidae	*Asemonea tenuipes*		1f		1(L)
42.		*Carrhotus viduus*		6m/4f		10
43.		*Epeus tener*		3m/3f		6
44.		*Hasarius adansoni*		25f	1m/10f	36
45.		*Menemerus bivittatus*		1m/5f		6
46.		*Phidippus yashodharae*		7f		7
47.		*Plexippus paykulli*		4m/36f	5m/15f	60
48.		*Plexippus petersi*		4m/30f	16f	50
49.		Telamonia dimidiate		2m/10f	1m/15f	28

Sr.No.	Family	Taxon	Collection methods			Total (Status)
			Arial	Ground	Beating	
50.	Sparassidae	*Heteropoda leprosa*		1m/7f		8
51.		*Heteropoda nilgirina*		2m/15f	4f	21
52.		*Heteropoda venatoria*		1m/12f	2m/6f	21
53.		*Olios milleti*		1f		1(a,L)
54.	Tetragnathidae	*Leucauge decorate*	4m/28f			32
55.		*Leucauge tessellata*	3m/10f			13
56.		*Tetragnatha javana*	2f			2(b,L)
57.		*Tetragnatha andamanensis*	2f			2(b)
58.		*Tetragnatha mandibulata*	1m/1f			2(b,L)
59.	Theraphosidae	*Ischnocolus khasiensis*		1m/2f		3
60.	Theridiidae	*Achaearanea*		1f	1f	2(b)
61.		*Argyrodes andamanensis*	1m/1f		1f	3
62.		*Argyrodes argentatus*	1f			1(a,L)
63.		*Argyrodes flavescens*	1f			1(a,L)
64.		*Argyrodes gezedes*	1f			1(a,L)
65.		*Theridion manjithar*	2m/16f		1m	19
66.	Thomicidae	*Camaricus formosus*	2f		1f	3
67.		*Misumena chrysanthemi*	1f			1(a,L)
68.	Uloboridae	*Uloborus danolius*	4f			4
		Total	**525**	**477**	**160**	**1162**

Table 2: Chao and Jack-knife estimates of spider species richness

	Chao	Jack-knife
Species Richness	$S^*_{chao} = 71.57$	$S^*_{jack} = 77.93$
Standard error	S.E = 2.39	S.E = 4.38

Table 3: Numbers of individuals, adults and species of adult spiders according to the collecting method

Collecting Methods	No. of sample units	No. of individuals	No.of adults	Mean no. of adults per sample unit	% of total adults	No.of species	Mean No. of species per sample unit	% of total species
Aerial	120	986	525	4.375	45.18	39	0.33	56.52
Ground	120	743	477	3.975	41.05	28	0.23	40.58
Beating	120	503	160	1.333	13.77	26	0.22	37.68
Total	120	2232	1162	9.683	100	69	0.58	100

facing the problem of habitat destruction and fragmentation. There is an urgent need for more studies in this field, which will be the base line data for the future studies in Assam.

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